



(19) Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) Publication number : **0 373 701 B1**

(12)

## EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification :  
**26.04.95 Bulletin 95/17**

(51) Int. Cl.<sup>6</sup> : **H01J 1/14**

(21) Application number : **89203112.1**

(22) Date of filing : **07.12.89**

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### (54) Oxide cathode.

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(30) Priority : **13.12.88 NL 8803047**

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(43) Date of publication of application :  
**20.06.90 Bulletin 90/25**

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(45) Publication of the grant of the patent :  
**26.04.95 Bulletin 95/17**

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(84) Designated Contracting States :  
**DE FR GB IT NL**

(56) References cited :  
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**Description**

The invention relates to a cathode for use in an electron beam having a supporting body substantially consisting of nickel and being coated with a layer of electron-emissive material comprising alkaline earth metal oxides and at least comprising barium.

Such cathodes are generally known and are described, for example in "Advances in Electronics and Electron Physics", 25, 211-275 (1968) and in the European Patent Application number 210.805. The emission of such cathodes is based on releasing barium from barium oxide. In addition to the barium oxide, the electron-emissive material usually comprises strontium oxide and sometimes calcium oxide.

10 The actual emission is substantially ensured by small regions (so-called "sites") having the lowest effective work function for electrons which are spread over the electron-emissive material. In practice sites having a slightly higher work function will hardly contribute to the electron current generated by the cathode.

For a high effective electron emission it is therefore favourable if the number of sites with the lowest possible work function is increased as much as possible in the total distribution of sites.

15 A cathode according to the invention is therefore characterized in that the electron-emissive material comprises 0.1-10% by weight of hafnium oxide or zirconium oxide.

In a preferred embodiment the electron-emissive material comprises 0.2-5% by weight of hafnium oxide or zirconium oxide.

During experiments it was found that the lifetime of a cathode of the type described in the opening paragraph could be increased considerably by adding hafnium oxide in particular.

20 It is known from JP-A- 51/48584 to use zirconium oxide in a cathode which further comprises an oxide of an alkaline metal oxide such as barium, calcium or strontium. Contrary to the present invention, this document is not involved with a cathode for use in an electron beam tube but solely with a cathode for use in a fluorescent lamp.

25 The invention will now be described in greater detail with reference to an embodiment and the drawing in which Fig. 1 is a diagrammatic cross-section of a cathode according to the invention.

In this embodiment the cathode 1 of Fig. 1 comprises a cylindrical cathode shaft 3 having a cap 7. The cap 7 consists substantially of nickel and may comprise reducing means such as, for example silicon, magnesium, manganese aluminium and tungsten. The cathode shaft 3 accommodates a helical filament 4 which consists of a helically wound metal core 5 and an electrically insulating aluminium oxide layer 6.

30 An approximately 70 µm thick layer of emissive material 2 is provided on the cap 7, for example by means of spraying or by means of the method described in USP 4,197,152. The layer 2 comprises, for example a mixture of barium oxide and strontium oxide obtained by providing barium strontium carbonate and by subsequently decomposing it or a mixture of barium oxide, strontium oxide and calcium oxide.

35 According to the invention the layer 2 also comprises approximately 2.5% by weight of hafnium oxide or approximately 1.5% by weight of zirconium oxide (calculated as a percentage of the quantity of barium strontium carbonate) which, in the case of spraying, may be added in the form of a powder to the spraying suspension. This yields a cathode having improved emission properties, notably with regard to the lifetime.

40 In lifetime tests it was found that at an unchanged filament voltage the addition of the said oxides led to a variation in emission properties which was considerably less than in the conventional cathodes. Therefore, they had a longer lifetime in the case of an equal or even higher load.

This will be illustrated with reference to the following test results. The emission properties of cathodes having the said additions to the layer of the emissive material were determined after 1000 operating hours at a filament voltage of 7 Volts, which is comparable to approximately 5000 real operating hours.

45 The emission measurements prior to and after this lifetime test were performed at a filament voltage of 7 V, more specifically after 30 seconds of current at a cathode load of 2.2 A/cm<sup>2</sup> (so-called  $\Delta i_k$  measurement). This yielded the following results:

Type of addition to the emissive layer	Reduction of the emission $(\Delta \Delta i_k)$	(%)
5      none (reference)		30
10     2.5% by weight of $\text{HfO}_2$		4.4
1.5% by weight of $\text{ZrO}_2$		9.5

Consequently, the additions used yielded cathodes whose long-term emission behaviour had improved by a factor of 3-7. A further improvement, obtained by slightly modifying the various percentages, is not excluded.

Also emissive layers provided with both hafnium oxide and zirconium oxide are possible.

## 20    Claims

1. A cathode for use in an electron beam tube having a supporting body substantially consisting of nickel and being coated with a layer of electron-emissive material comprising an alkaline earth metal oxide, including at least barium oxide characterized in that the electron-emissive material comprises moreover 0.1-25% by weight of hafnium oxide and/or zirconium oxide.
2. A cathode as claimed in Claim 1, characterized in that the electron-emissive material comprises 0.2-5% by weight of hafnium oxide or zirconium oxide.
3. A cathode as claimed in Claim 1 or 2, characterized in that the electron-emissive material substantially comprises barium oxide and strontium oxide.
4. A cathode as claimed in any one of Claims 1 to 3, characterized in that the supporting body comprises reduction means.
- 35    5. An electron beam tube provided with a cathode as claimed in any one of Claims 1 to 4.

## Patentansprüche

- 40    1. In einer Elektronenstrahlröhre zu verwendende Kathode, die einen Trägerkörper hat, der im wesentlich aus Nickel besteht und mit einer Schicht aus elektronenemittierendem Material beschichtet ist, das Alkal-Erdmetalloxide und wenigstens Barium enthält, dadurch gekennzeichnet, daß das elektronen-emittierende Material außerdem 0,1 bis 10 Gewichtsprozent Hafniumoxid und/oder Zirkoniumoxid enthält.
2. Kathode nach Anspruch 1, dadurch gekennzeichnet, daß das elektronen-emittierende Material 0,2 bis 5 Gewichtsprozent Hafniumoxid oder Zirkoniumoxid enthält.
3. Kathode nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß das elektronen-emittierende Material hauptsächlich Bariumoxid und Strontiumoxid enthält.
- 50    4. Kathode nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß der Trägerkörper Reduziermittel enthält.
5. Elektronenstrahlröhre, die mit einer Kathode nach einem der Ansprüche 1 bis 4 ausgestattet ist.

**Revendications**

1. Cathode, pour utilisation dans un tube à faisceaux d'électrons ayant un corps support composé essentiellement de nickel et revêtu d'une couche de matériau émetteur d'électrons comprenant un oxyde métallique alcalino-terreux, comprenant au moins de l'oxyde de baryum, caractérisée en ce que le matériau émetteur d'électrons comprend de plus de 0,1 à 10% en poids d'oxyde d'hafnium et/ou d'oxyde de zirconium.
2. Cathode selon la revendication 1, caractérisée en ce que le matériau émetteur d'électrons comprend de 0,2 à 5% en poids d'oxyde d'hafnium ou d'oxyde de zirconium.
3. Cathode selon la revendication 1 ou 2, caractérisée en ce que le matériau émetteur d'électrons comprend essentiellement de l'oxyde de baryum et de l'oxyde de strontium.
4. Cathode selon l'une quelconque des revendications 1 à 3, caractérisée en ce que le corps support comprend un moyen de réduction.
5. Tube à faisceaux d'électrons équipé d'une cathode selon l'une quelconque des revendications 1 à 4.

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